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## REVIEW ARTICLE

**A REVIEW ON ANTI-DIABETIC POTENTIAL OF GENUS *SOLANUM* (SOLANACEAE)****Raghuram Kandimalla, Sanjeeb Kalita, Bhaswati Choudhury, Jibon Kotoky\***

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**ABSTRACT**

The *Solanum* genus (*Solanaceae* family) comprised of one thousand five hundred species and most of the members of the genus are widely used as food and traditional medicine. Diabetes mellitus is a common and serious metabolic disorder throughout the world. Traditionally used medicinal plants play an important role as alternative medicine due to less toxic effects and cost. The aim of this review is to report anti-diabetic potential of plants of *Solanum* genus on the basis of the secondary data published. This will help in identifying the state of anti-diabetic knowledge in regards to this genus and to propose future research priorities. The major scientific database including Science direct, SciFinder and Google scholar were searched for information on *Solanum* genus using various keyword combinations. A total of eight *Solanum* species were reported in literature to have anti-diabetic property. Some of the plant species reported to modify different complications of diabetes like hyperlipidemia, oxidative stress in diseased animals. On the basis of anti-diabetic and other related activities, plants of *Solanum* genus are the most promising plant species to develop as efficacious and safer medicines for diabetes and its complications. Considering the present status of this disease and potential of *Solanum* genus, there is much scope of studying this genus thoroughly, which may result in development of affordable, efficacious and safer remedies against the silent killer disease.

**Key words:** *Solanum* genus, anti-diabetic activity, hyperlipidemia, oxidative stress, methyl caffeate.

**INTRODUCTION:**

*Solanum* is the largest angiosperm genera, with approximately 1500 species distributed worldwide. It belongs to the kingdom Plantae, Order Solanales, Family Solanaceae. The genus includes important economic plants such as the tomato, potato and brinjal, as well as a number of lesser-known cultivated species, such as the pepino (*S. muricatum* Aiton.), naranjilla (*S. quitoense* Lam.), cocona (*S. sessiliflorum* Dunal.) and tree tomato (*S. Betaceum* Cav.)<sup>1, 2</sup>. Diabetes Mellitus is one of the major metabolic disorders and affects majority of the population worldwide. Underutilization of glucose is one of the major concerns of diabetes mellitus. According to World health organization (WHO) 347 million people worldwide are suffering from diabetes and 1.5 million deaths was reported directly due to diabetes by 2012. Oral hypoglycemic agents and insulin are the major drugs of treatment of diabetes and are effective in controlling high blood glucose levels; but they have more side effects and fail to significantly alter the course of diabetic complications<sup>3</sup>. In this scenario, there is a need to look for more efficacious agents with lesser side effects. Plant remedies have been used throughout the world to treat diabetes from ancient days. Plants are good source of drugs and many drugs in market have been derived

directly or indirectly from the plant source. More than 800 plant species and compounds, like alkaloids, glycosides, steroids, peptidoglycans, terpenoids, amino acids isolated from the plant source possess anti-diabetic activity<sup>4</sup>. Out of the several medicinal plants used in the treatment of diabetes, plants of *Solanum* genus reviewed in the present study. The following review will cover the species distribution, anti-diabetic potential of plant extracts and their isolated compounds.

Information regarding the plants and their anti-diabetic property was gathered by searching with different keyword combinations in databases like ScienceDirect, PubMed, Scifinder and Google scholar. Secondary data gathered was analyzed and reported in present study.

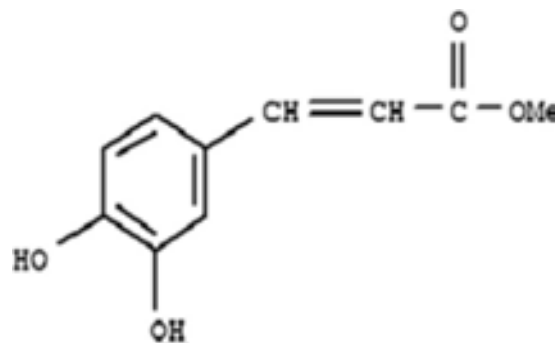
***Solanum anguivi*:**

*Solanum anguivi* Lam. is a non-tuberous and widely distributed plant that possesses various medicinal properties. Mostly, the plant prefers to grow in humid temperature and commonly found as weed in gardens widely distributed in tropical Africa, South Africa and Arabian peninsula, Aldabra, Macarena islands. It is a rare ethno-medicinal herb belonging to the family Solanaceae<sup>5, 6</sup>. Saponins from *Solanum anguivi* fruit

have ability to attenuate the hyperglycaemia mediated oxidative stress and hyperlipidaemia. Saponins administration at 20-100 mg/kg significantly reduced the elevated levels of glucose, total cholesterol (TC), total triglycerides (TG), low density lipoproteins (LDL) and increased high density lipoprotein (HDL) in the serum towards normalcy when compared to the diabetic control. Saponins also reported for strong inhibition of lipid peroxidation and increased the levels of antioxidant enzymes (superoxide dismutase and catalase) in the serum, liver and pancreas when compared to the diabetic control<sup>7</sup>. Saponins from the *S. anguivi* fruit reduces the lipid peroxidation in brain and liver and restore the levels of anti-oxidant enzymes in heart and kidney of alloxan induced diabetic rat<sup>8</sup>. Aqueous extract of *S. anguivi* fruit significantly inhibits malondialdehyde production in rat brain when compared with control in *In vitro* condition. The reason behind this inhibitory effect is reported because of the total phenolics, total flavonoid, vitamin C content and Fe<sup>2+</sup> chelating ability of the plant extract<sup>9</sup>.

#### ***Solanum torvum*:**

*Solanum torvum* Swartz. (Solanaceae) is a small tree of about four meter tall, evergreen, branched with white flowers. It occurs commonly in the moist farms of India and is widely distributed in Malaysia, China, Philippines and Tropical America<sup>10</sup>. The fruits of *S. torvum* are edible and commonly available in the markets, fruit utilized as vegetable and regarded as an essential ingredient in the South Indian diet<sup>11</sup>. Methanolic extract of *S. torvum* fruit at 200 and 400 mg/kg containing phenolic compounds was reported to lower blood glucose levels in streptozotocin induced diabetic rats. It is also reported to enhance insulin secretion due to regeneration of  $\beta$ -cells, reduce oxidative stress and modulate enzymes responsible for glucose metabolism<sup>12</sup>. Methyl caffeate (Fig.1.) a chemical compound was isolated from the fruit of *S. torvum*. This compound was evaluated for anti-diabetic property at 10, 20 and 40 mg/kg. Methyl caffeate showed significant hyperglycaemia activity in streptozotocin induced diabetic rat dose dependently by up regulation of GLUT4 and regeneration of  $\beta$ -cells in the pancreas<sup>13</sup>. Polyphenolic compounds from *S. torvum* were having cytochrome P450 2E1 (CYP2E1) catalytic inhibiting activity (57.16 %). The IC<sub>50</sub> value of CYP2E1 catalytic inhibiting activity level was reported as 5.14 mg/mL. One gram of concentrated *S. torvum* extract reported to have an antioxidant activity index of 3.68 mg of trolox and 360.53 mg of ascorbic acid equivalents. *S. torvum* also reported as rich source of phenolic and flavonoid content which have CYP2E1 enzyme inhibiting and free radical scavenging properties, as related to lipid peroxidation and superoxide anion activity<sup>14</sup>. Clinical studies proved that dry powder of *S. torvum* (Sundakai) have no significant changes with respect to glucose, lipid profile, glycated proteins, and uronic acid levels in type-II diabetic patients<sup>15</sup>.



**Fig.1. Methyl caffeate from *Solanum torvum***

#### ***Solanum lycocarpum*:**

*Solanum lycocarpum* St. Hill widely known as 'Lobeira' is a medicinal plant species growing in the Brazilian savanna<sup>16</sup>. The species is widely used as a hypoglycaemic agent. *S. lycocarpum* flour treated diabetic rats showed reduced levels of serum glucose, water and food intake, urine excretion, and urine sodium concentration compared with diabetic control rats<sup>17</sup>. Administration of fruit extract of *S. lycocarpum* at 1000 mg/kg in alloxan induced diabetic rats reported for blood glucose lowering activity and improved different blood parameters in diabetic rats<sup>16</sup>. Both pre-clinical and clinical investigation proved that starch obtained from the *S. lycocarpum* fruit have no hypoglycaemic activity in streptozotocin induced diabetic mice and in diabetic patients respectively<sup>18</sup>. Polysaccharides obtained from *S. lycocarpum* fruits were reported to have hypoglycaemic and hypocholesterolemic activity<sup>19</sup>. Plant reported as an anti-diabetic plant by some group of researchers<sup>20</sup>.

#### ***Solanum melongena*:**

*Solanum melongena* commonly called as "Eggplant" is used mainly as a food crop, it does also have various medicinal uses that make it a valuable addition to the diet. *In vitro* evaluation of water extract of *S. melongena* two eggplant types, such as White and Graffiti have positive effect on hyperglycemia risk factors, biomarker of hypertension, moderate antioxidant activity and good inhibitory action against carbohydrate modulating enzyme such as  $\alpha$ -glucosidase related glucose absorption in the intestine<sup>21</sup>. *S. melongena* have ability to inhibit the starch hydrolyzing enzymes like  $\alpha$ -amylase and  $\alpha$ -glucosidase in dose dependent manner, where it inhibits  $\alpha$ -glucosidase strongly and  $\alpha$ -amylase moderately<sup>22</sup>.

#### ***Solanum xanthocarpum* (*Solanum surattense*):**

*Solanum xanthocarpum* is a prickly diffuse bright green perennial herb and distributed throughout India, found mostly in dry places as a weed on road side and waste lands. It is one of the members of the Dashamoola (Ayurvedic formulation). Ethanolic root extract of *Solanum surattense* at 200 and 400 mg/kg produce anti-hyperglycaemic activity and improved serum enzymes and lipid profile in alloxan induced diabetic rat<sup>23</sup>. *In vitro* raised plant *S. xanthocarpum* methanolic leaf extract at 200 mg/kg showed improved insulin secretion and reduce hyperglycemic activity<sup>24</sup>. Aqueous extract of

*S. xanthocarpum* was reported to have insulin like effect on alloxan induced diabetic rat and reduces the high blood sugar levels<sup>25</sup>. *Solanum surattense* leaf extract at 100mg/kg reported for the anti-hyperglycaemic and anti-hyperlipidemic activity in streptozotocin induced diabetic rats<sup>26</sup>.

#### ***Solanum trilobatum*:**

*Solanum trilobatum*, a thorny creeper with bluish violet flowers, more abundantly available in South India widely used traditionally in Siddha system of medicine, to treat various diseases. Plant popularly called as 'ththuvali' by the local tribes, villagers and herbalogists of Tamilnadu<sup>27</sup>. Ethanolic leaf extract of *S. trilobatum* at 100 and 200 mg/kg have ability to lowers hyperglycaemia and free radical formation in alloxan induced diabetic rats<sup>28</sup>. Water extract of *S. trilobatum* leaf was reported to have anti-diabetic property in alloxan induced diabetic rats<sup>29</sup>.

#### ***Solanum nigrum*:**

*Solanum nigrum* Linn. commonly known as black berried nightshade is fairly or short-lived perennial shrub found in many wooded areas. Plant distributed throughout India, Ceylon and all temperate and tropical regions of the world<sup>30</sup>. Aqueous and hydro alcoholic extracts of the whole plant parts at 200 and 400 mg/kg possess significant blood glucose lowering effect in oral glucose tolerance test<sup>31</sup>. Aqueous leaf extract of the plant at 50 and 100 mg/kg was reported for anti-diabetic activity in alloxan induced diabetic rats<sup>32</sup>. Aqueous extract of *S. nigrum* fruits has the ability to reduce increased blood sugar levels and hyperglycemia mediated vascular complications in STZ induced diabetic rats<sup>33</sup>. Water extract of *S. nigrum* leaves at 400 mg/kg was reported to have hypoglycemic response in alloxan induced diabetic rats<sup>34</sup>. Oral glucose tolerance test of *S. nigrum* leaves showed no significant decrease in blood glucose levels in glucose fed mice<sup>35</sup>.

#### ***Solanum pubescens*:**

*Solanum pubescens* (solanaceae) is a shrub or rather stiff herb growing like a small tree. They grow throughout the world in tropical and warmer regions<sup>36</sup>. Methanolic leaf extract of the plant at 300 mg/kg was reported to decrease the elevated blood glucose and lipid parameters in alloxan induced diabetic rats<sup>37</sup>.

#### **CONCLUSION:**

This review represents eight *Solanum* species from Solanaceae family and summarizes the anti-diabetic potential of the plants of *Solanum* genus. *Solanum* species widely distributed throughout the world where many species are used for the medicinal purpose as well as consumed as food. Biochemical compounds like saponins and phenolic compounds were reported from the plant species which might contribute directly or indirectly to the anti-diabetic property highlighted in this review. Furthermore one compound methyl caffeate from *S. torvum* was found to be bioactive against diabetes mellitus, this compound can be considered to develop a novel anti-diabetic molecule. The present review can be used to validate the anti-diabetic potential of *Solanum* genus. There are many plant species in *Solanum* genus which is not explored for their anti-diabetic potential. Except methyl caffeate from *S. torvum*. There is no compound reported for their anti-diabetic potential. Therefore, exploration of other plant species in *Solanum* genus for anti-diabetic property and their compound isolation and validation will be very significant to human race.

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